

Differential Exposure of Brickwork to Hydrogen Cyanide during World War Two

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This article was first submitted to the Royal Society of Chemistry's journal *The Analyst*. They rejected it on the grounds that it did not have enough about analysis. The authors then submitted it to *Chemistry-a European Journal*. It was rejected in less than 24 hours on the grounds that it would not be "likely to attract a wider readership." While this article, with its heavy emphasis on chemistry, is atypical for *Inconvenient History*, we were convinced of its importance and believe, especially in light of the rejections received from the journals mentioned above, that we had a special responsibility to publish it. Ed.

Abstract

To this day, brick and mortar from the walls of the extant delousing chambers at the infamous Auschwitz-Birkenau concentration camp contain substantial amounts of Iron Blue residue, $\text{Fe}^{\text{III}}_4[\text{Fe}^{\text{II}}(\text{CN})_6]_3$, also known as Berlin Blue or Prussian Blue. As this compound is insoluble to rain and resistant to wind and other natural forces, it is not surprising its presence has persisted the past seven decades. It is usually, but not always, quite visible to the naked eye.

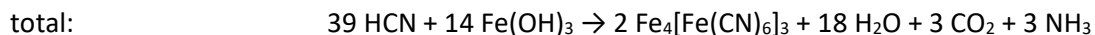
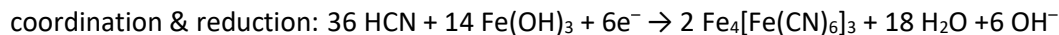
Various iron(III) oxide compounds are common in brickwork (bricks, mortar, cement, concrete, plaster), while cyanide compounds are not. The latter's presence in the brickwork of delousing chambers at Auschwitz-Birkenau is undoubtedly a function of exposure to gaseous hydrogen cyanide used during the camp's operation between late 1941 and early 1945. All analyses of exposed surface of other objects have to date revealed cyanide residues that are either very close to or below the detection limit. Difficulties with the existing analytical methods, which are not designed for these atypical host materials, need to be overcome to allow more definite conclusions.

Introduction

Zyklon B, which is liquid hydrogen cyanide (HCN) absorbed on diatomaceous earth or gypsum granules, started its innocuous career in the 1920s as a disinfestation agent. The broad consensus today is that during the Second World War this product was used to kill hundreds of thousands (or millions) of Jews in homicidal gas chambers, in German wartime camps. But a consensus also seems to exist that Zyklon B was used throughout the German system of concentration and labour camps for its originally intended purpose: the disinfestation of inmate living quarters, clothes, linens and mattresses. It was the advent of DDT and its successors, just as the war was ending, which reduced the use of HCN for disinfestation purposes to a niche market.

The use of hydrogen cyanide in buildings to fight pests like woodboring beetles has been common practice for many decades and only rarely led to problems like chemical reactions of the HCN with building materials, although a few cases have been reported, some of which involve the reaction of HCN with iron compounds contained in the walls resulting in Iron Blue.[\[3\]](#)

The blue discoloration which has been noted in the disinfestation, or delousing, chambers at the Auschwitz and Birkenau camps most probably resulted from a similar reaction. The idealized reactions underlying the conversion of iron(III) oxide to Iron Blue in wall material (brick, cement, mortar, concrete, plaster) in the presence of large amounts of gaseous HCN are probably as follows:[\[4\]](#)



Iron(III) is known for eagerly binding cyanide ions, and the resulting hexacyanoferrate(III) is known to be a strong oxidising agent, which in an alkaline medium is capable of oxidising even trivalent to hexavalent chrome.[\[5\]](#) Considering that lime and cement mortars remain alkaline for quite a while (the higher the cement content, the longer the material will remain alkaline), the above formation mechanism for Iron Blue in walls exposed to HCN appears most likely, where hexacyanoferrate(III) oxidises excess cyanide, while the resulting hexacyanoferrate(II) combines with remaining iron(III) ions over time to slowly form Iron Blue.

Evaluation of Past Sampling and Analytical Methods

Well over a hundred specimens have been sampled from the walls of various buildings at the Birkenau and Auschwitz wartime camps by four different surveys. In sequence of publication these were: Leuchter (USA, 1988),[\[6\]](#) Rudolf (Germany, 1993),[\[7\]](#) Ball (Canada, 1993) [\[8\]](#) and Markiewicz *et. al.* (Poland, 1994). [\[9\]](#)

Whereas Leuchter and Rudolf measured total cyanide in the brickwork using an internationally recognized analytical procedure that dissolves the total cyanide content, the Polish study (Markiewicz *et. al.*) aspired to measure only the water-soluble cyanide components, *i.e.* those components that might be presumed to no longer exist, because soluble cyanide compounds are notoriously unstable and decompose under the influence of air humidity with a half-life of mere days and thus cannot be expected to have survived five decades of exposure to the elements.[\[10\]](#) Hence, whatever can be measured with such a method, it certainly cannot conceivably appertain to soluble cyanide compounds deposited 50 years earlier, no matter how reproducible the results. [\[11\]](#)



Fig. 1: Interior photograph taken from the ruins of Morgue 1 (alleged "gas chamber") of Crematorium II. The arrow points to a sample taking location by Germar Rudolf. (© 1991 Karl Philipp)

The reason given by the Polish scientists to exclude long-term-stable iron cyanide compounds from their analysis deserves a brief discussion. If valid, a completely different approach to the issues at hand would be required.

Without considering possible pathways for the formation of long-term-stable iron cyanides in wall materials exposed to HCN, the Polish team assumed that maybe "the delousing room[s] were coated with this [Iron Blue] dye as a paint."^[12] Their supposition was based on a paper by Austrian chemist Josef Bailer, published in a political brochure by the Austrian government.^[13] In order to exclude this pigmentation from the analysis, they decided to apply a method that was insensitive to iron cyanides.

It is worth emphasizing that a few published reports exist where a single fumigation of old churches with Zyklon B (or its successor product) resulted in exactly the same spotty blue plaster discoloration as observed here, caused by the formation of Iron Blue.

Iron Blue is not well-suited for wall paint, as it is unstable in an alkaline environment, and because fresh wall plasters saturated with $\text{Ca}(\text{OH})_2$ may have pH values as high as 13,^[14] which decreases only slowly with time. Studies on the stability of Iron Blue have determined that the pigment is still stable at a pH value of 9 to 10.^[15] Experiments conducted by Rudolf have established a stability limit of pH 10-11 for fresh Iron Blue precipitations. Beyond this value, $\text{Fe}(\text{OH})_3$ precipitates, leaving the re-dissolved hexacyanoferrate(II) ions behind, thus reversibly destroying the pigment. In their product information sheets for Iron Blue pigments, the German chemical company Degussa describes Iron Blue's "lime fastness" – a measure of stability on fresh wall plasters – as "not good."^[16] Although the pigment's destruction on alkaline plaster is reversible once the wall loses some of its alkalinity, the result would still be a patchy blue color which changes its hue with time– hardly what a customer buying blue wall paint would desire. As a result, Iron Blue, when used in blue paint, is not the only substance added to impart blue pigment.^[17]

Even if such wall paint had been available during the war, it is not likely that German camp authorities would have used it exclusively in their delousing chambers. And this would have been true not only at Auschwitz and Birkenau,^[18] but also at the Majdanek and Stutthof camps, whose delousing chambers show an identical Iron Blue discoloration found nowhere else in the camp.^[19]

The Auschwitz delousing chambers under investigation here had received a coat of white lime paint. Adding another layer of paint to it would have made little sense. Also, any layer of paint leaves behind a pattern of brush strokes and a defined layer containing the pigment together with the other components of the paint, such as binders, fillers and additives, which usually make up the bulk of the paint, none of which has been detectable in the cases examined here.



Fig. 2: Interior northwest room in the Zyklon B disinfestation wing of BW 5a in the Birkenau camp\. (© 1991 Karl Philipp)

Some of Rudolf's samples (see below) were high in cyanide but showed no discoloration, having originated from deeper layers of the plaster, which could not have been caused by a superficial layer of blue paint. In addition, high cyanide levels are sometimes detectable even in samples taken from the outside of the buildings, which are plain, unplastered brick walls, with no paint whatsoever. [20]

We therefore do not accept that blue wall paint was the reason for the blue discolorations of the plaster, mortar and bricks of Third Reich era Zyklon B delousing-chamber walls. Excluding insoluble iron cyanides from the analysis, as the Polish study did, means excluding the majority of detectable cyanide components, which is hardly a valid approach.

Whilst the Polish team did have permission from the Polish authorities to take its wall samples, Leuchter and Rudolf took their samples clandestinely. Considering that secret sampling is not unusual and sometimes necessary for the sake of independent investigations, this legal flaw may have no relevance to our analysis.

The Ball study was small, a mere six wall samples taken in all, without any precise location given. A fierce debate, colored alas by political agendas, has swirled around the question of what parts of old brickwork may or may not have been regularly exposed to hydrogen cyanide gas. Hence evidence locating each sampling site is here rather vital in reconstructing the historical use. We have here excluded Ball's samples on the grounds that its author has not been available to answer questions concerning the exact locations of his samples.

Depth of Penetration

Possibly influenced by the hypothesis that the Iron Blue found in the walls of the Auschwitz delousing chambers might stem from wall paint and therefore is expected to be found only on the walls' surface, Dr Roth, the chemist who worked at Alpha Laboratories which analysed Leuchter's specimens back in 1988, stated in a later media interview that cyanide gas would only be absorbed into the first ten micrometres or so of wall surface. [21] That could be so for stone but neither for brick nor for mortar or plaster. Were his claim valid, it would invalidate the very concept of wall-sampling to assess historical cyanide exposure. We shall here comment on 'Roth's hypothesis':

1. First we may juxtapose Roth’s media statement above with the statement he made while testifying under oath as an expert witness during a trial for which he had unwittingly prepared the analyses in question:[\[22\]](#)

“In porous materials such as brick or mortar, the Prussian blue [read: hydrogen cyanide] could go fairly deep as long as the surface stayed open, but as the Prussian blue formed, it was possible that it would seal the porous material and stop the penetration.”

2. Furthermore, expert literature is detailed in that hydrogen cyanide is an extremely mobile chemical compound with some of its physical properties quite comparable to water.[\[23\]](#) It can quite easily penetrate through thick, porous layers like walls, as was shown during fumigation experiments in the late 1920s.[\[24\]](#)

3. In addition, it is generally known that cement and lime mortars are highly porous materials. The German official standard DIN 4108, Parts 3 to 5, for instance, deals with diffusion of steam into building materials.[\[25\]](#) It deals to a large degree with the so-called diffusion resistance factor of building materials, a dimensionless number indicating how much longer the diffusion of a gas takes to penetrate a layer of certain materials compared to the time it takes to diffuse through the same layer of still air. This coefficient applies for any type of gas, including hydrogen cyanide. In the list of 100 different building materials compiled in DIN 4108, Part 4, one can find lime and cement mortar with diffusion resistances from 15 to 35, in which case the resistance grows with increasing cement content. Hence, in such materials, there does not exist anything like a defined layer of 0.01 mm beyond which hydrogen cyanide could not diffuse, as for comparison there would be no reason why water could not penetrate a sponge deeper than a millimetre. Steam, for example, whose physical behaviour is comparable to hydrogen cyanide, can very easily penetrate walls.

4. Finally, Rudolf has taken wall samples from the outside of delousing chambers, as well as from deeper layers of the material:

Table 1: Cyanide Levels of External and Deep-Layer Samples

Sample #	Location	mg CN ⁻ /kg
11	inside, plaster from 1 mm to 10 mm depth	2,640
13	inside, plaster from 2 mm to 10 mm depth	3,000
15a	outside, mortar from 0 mm to 3 mm depth	1,560
15c	outside, brick from the outer 1 mm	2,400
16	outside, brick from 0 mm to 7 mm	10,000
17	inside, plaster from 4 mm to 10 mm	13,500
19a	inside, plaster from 0 mm to 4 mm	1,860
19b	inside, plaster from 4 mm to 8 mm	3,880

Rudolf’s Samples 15b & c were taken from a brick on the outside of one of the Birkenau delousing chambers. Whereas Sample 15c consisted of the upper, stained layer some 1 mm thick of the brick

scraped off with a spatula, Sample 15b (not listed above) consisted of the sample's remainder. The upper blue layer had a cyanide value of 2,400 ppm, whereas the rest of the sample (15b) had a value of only 56 ppm, indicating that almost all cyanide is concentrated on the upper millimetre of the brick – with no paint visible, though. As Rudolf has indicated, this may be due to the fact that the iron oxide contained in bricks is rather inert to chemical reactions due to the sintering process that all the brick's compounds undergo when it is made, with the exception of the brick's surface, where environmental influences (UV radiation, acid rain etc.) activate the iron.

Rudolf's mortar and plaster Sample Pairs 9 & 11, 12 & 13, 19a & b, which were each taken at the same spot but at different depths, as well as 17, taken from below the overlaying lime plaster (which is similar to 19a), show that the situation is drastically different with plaster:

Table 2: Penetration Depth of HCN into Walls with Resulting Iron Blue Formation

Surface values		Deep-Layer Values		Outside values	
Sample	Values	Sample	Values	Sample	Value
9	0 – 2 mm: 11,000	11	1 – 10 mm: 2,640	–	–
12	0 – 2 mm: 2,900	13	2 – 10 mm: 3,000	–	–
–	–	17	4 – 8 mm: 13,500	16	0-7 mm: 10,000
19a	0 – 4 mm: 1,860	19b	4 – 8 mm: 3,880	–	–

The wall at the location where Samples 9 & 11 were taken showed a very intense, dark blue hue. The concomitant accumulation of Iron Blue on the surface is borne out by the very high amount of cyanide found there in comparison to the considerably lower, though still substantial amount in deeper layers. This surface accumulation is due to wall exposure to outdoor elements plus its direct contact with ground water. The Birkenau camp was erected in a swampy area: ground water slowly moving up through the wall and out towards the surface, where it evaporates, carries along soluble ions, including hexacyanoferrates, which subsequently accumulate at the walls' surface. This is also supported by the visible pattern of blue hues produced by this process, which seems to reproduce the underlying brick structure of that wall, probably caused by the different heat conductivities – and thus water evaporation rates – of the underlying material.[\[26\]](#)

In contrast to this no such accumulation has occurred at the location where Samples 12 & 13 were taken, which is an internal partitioning wall not exposed to the elements and in no direct contact with ground water. Hence, the lack of moisture in that wall has prevented the transport of soluble cyanides to the surface. As a consequence, an almost constant concentration profile results for the upper 10 mm of the wall.

Sample 17 was taken from the southern wall of the delousing wing of the hygiene building BW 5b at Auschwitz-Birkenau, a wall intensely exposed to the elements, as the winds and the rain come primarily

from the southwest to west in that area. [27] Since moisture is one main prerequisite for the absorption of HCN into building materials – the other being an elevated pH value – this could be why cyanide values are highest at this location. In fact, 74% of all the iron contained in this sample was converted to Iron Blue: we are dealing here with cyanide values very close to the saturation limit. Interestingly, the heavily eroded, hence chemically active bricks on the outside of this wall show a dark blue discoloration with cyanide values close to those measured in the lower layers of the plaster on the inside (Sample 16) suggesting that the entire wall is saturated through with Iron Blue, should anyone ever venture to take core samples from within it.

This may resolve the question, as regards which of Dr Roth's statements is tenable: without doubt, that which he made while under oath.



Fig. 3: Exterior southwest wall of the Zyklon B disinfestation wing of BW 5b in the Birkenau camp\ (© 1991 Karl Philipp)

Detection Limit and Reliability

The Polish study followed the method as defined by Epstein, who gives a detection limit of 0.2 mg/l for liquid samples. [28] The Polish team mysteriously averred, however, that their detection limit lay almost two orders of magnitude lower, at 3-4µg/kg according to experience they have gained with test measurements. We are far from accepting this parts-per-billion accuracy level claimed for a 1947 method but refrain from further comment.

This, in addition to the observations made above about the evidently wrong wall-paint hypothesis, led to our decision to exclude these results from our present comparative study concerned only with total wall cyanide measurement.

We are therefore left with the studies conducted by Leuchter and Rudolf. Using just these two published studies, we have here made several binary distinctions within the data, *e.g.* between outdoor wall samples exposed to the elements, and those from still-enclosed rooms, having intact ceilings. This may guide us as to the effect of weathering on the residual cyanide levels. Also, a differential between brick and mortar cyanide absorption would be of interest. We have endeavoured to ascertain a *control* level, *i.e.* a mean ferrocyanide level in dormitories, kitchens and washroom walls, rooms where nobody has alleged that regular exposure to hydrogen cyanide took place. From pooling the two data sets we have endeavoured to credibly ascertain this vital scientific metric.

We have not been primarily interested in the question of whether a deep blue ferrocyanide discoloration of the walls is present, or how that came into existence. The presence of this blue hue emerged only slowly after the war and was the stimulus for the original measurements of wall cyanides taken by Fred Leuchter. We suggest that the simple measurements of total cyanide as evaluated here do not depend upon such a discoloration. For instance, if a certain wall material contains some 1% of iron compounds, even its total conversion into Iron Blue would not necessarily lead to a noticeable change in hue, as 1% blue within 99% of, say, mortar-grey would hardly be noticeable to the human eye. This is borne out by Rudolf's Samples 19a & b, both of which had high cyanide levels, although neither showed any noticeable blue hue. Strong discoloration of wall surfaces must therefore depend on accumulation processes near the surface, *e.g.* due to humidity transporting still-soluble cyanide compounds like hexacyanoferrates to the surface, where it then slowly converted to Iron Blue. [\[29\]](#)

Leuchter and Rudolf both had their samples analysed by professional laboratories employing almost identical methods: grinding the solid samples in ball mills, then extracting the cyanide by boiling the powdered samples in hydrochloric acid. The forming HCN was driven out by means of a continuous air stream into a NaOH solution. This was then analysed photometrically. Even though there are more sensitive methods of detecting cyanide available today, they usually are incapable of dissolving Iron Blue, which is an integral part of a solid sample.

The detection limit of the methods used by Leuchter was given as 1 ppm, whereas Rudolf's laboratory claimed a limit of 0.5 ppm. The main weakness of these two investigations is arguably that many samples of interest exhibited cyanide levels very close to these detection limits.

The analytical method used was originally devised for liquid samples, whereas we are dealing with solid samples whose cyanide contents have to be dissolved before they can be measured. In addition, almost all analytical methods used to this day are susceptible to interference by a wide range of components. [\[30\]](#) One of them is of particular importance in our case: carbonates. In aqueous HCl, carbonates release CO₂, which thus gets transferred alongside HCN into the NaOH solution. The German DIN standard analytical method used for Rudolf's samples specifically mentions a potential interference of carbonate, which can mask small amounts of cyanide. [\[31\]](#) In the present case, carbonates are a main component of most samples (except bricks). It remains unknown to what extent a substantial amount of carbonate has affected the analysis. It may be safe to state, though, that the reliable detection limit under these circumstances can be expected to be considerably higher than is given for liquid samples with little or no carbonates.

To prove this point, Leuchter's laboratory re-analysed two low-level samples and made a spike analysis for a third. Rudolf had four of his samples re-analysed by a different laboratory. The results are given in Table 3.

Table 3: Reproducibility of Total Cyanide Analysis of Wall Samples by Rudolf and Leuchter (Results in mg CN⁻/kg)

Sample*	1st Result	2nd Result	% Recovery (1st/2nd)
L25	3.8	1.9	50
L30	1.1	ND	0

L26	1.3	–	140**
R3	6.7	ND	0
R8	2.7	ND	0
R11	2,640	1,430	54
R25	9.6	9.6	100
<p>* L = Leuchter's sample no.; R = Rudolf's sample no. ** A spike recovery was performed in this case, with only the percentage given.</p>			

Whereas all of Leuchter's samples are described as "brick," hence should have low contents of interfering carbonates, Rudolf's Samples 3, 8, and 11 were plaster samples rich in carbonates. The the only sample which could be reproduced with accuracy, #25, was of brick. As can be seen from this, the reliability of analytic results even of samples with high levels of cyanide is problematic, whereas the reliability of result of samples with cyanide levels close to the formal detection limit is approaching zero. To put this into perspective, a spike recovery rate of up to $\pm 10\%$ is considered to signify a reliable analytic method. The acceptability limits are generally considered to be at $\pm 25\%$. Here we are dealing here with rates between +40% and –100%.

The Delousing Chambers

Our first division of the data concerns wall samples taken from what are agreed by all sides to have been innocuous delousing chambers in the Auschwitz-Birkenau hygiene buildings BW 5a and BW 5b (BW standing for *Bauwerk* = building). Erected in 1941 as a preventive measure against the outbreak of typhus in this German wartime camp, they exposed clothing and bedding to something around a thousand parts per million of cyanide gas for several hours. [32] They were designed to be used in conjunction with Zyklon B. The type used at Auschwitz consisted of highly porous gypsum granules soaked with liquid hydrogen cyanide. [33] The liquid boiled at 25.7°C, so slight warming was recommended to accelerate the evaporation of the compound, although it was not required due to the high vapour pressure of HCN even at low temperatures.

Only a single sample from a delousing chamber (DC) wall was taken by Fred Leuchter, at Birkenau, even though it was quite a substantial one, but this was more than compensated by Rudolf's quite extensive sampling inside and out of two delousing chambers in the same camp. Indeed we may at once divide Rudolf's 16 DC samples into those from indoor walls versus those from outdoor walls of the same buildings:

Delousing room, inside: $5,431 \pm 3,962$ ppm (n=11),

outside: $3,010 \pm 3,999$ ppm (n=5).

Such huge standard deviations may be expected among samples taken at different locations with different exposures and histories: strictly speaking, one should only consider them for multiple analytical results of the same sample or from very similar samples, which is not here the case.

All of the walls here sampled (except for Rudolf's Samples #19a&b as mentioned above) were stained blue to some degree. Clearly, the hydrogen cyanide used on a regular basis in these delousing chambers has penetrated right through the walls, being 45% lower on the outside than on the inside forty years later.

Comparing both Leuchter and Rudolf DC samples versus all other samples of measurable cyanide level gives:

Table 4: Cyanide Levels in Delousing Chambers versus Other Locations in ppm

Sampler	Delousing Chambers	Other locations
Leuchter	1,050 (n=1)	1.22 ± 1.94 (n=33)
Rudolf	4,674 ± 4,009 (n=16)	2.61 ± 3.6 (n=16)
<i>Overall mean value:</i>	<i>4,461 ± 3,980 (n=17)</i>	<i>1.68 ± 2.6 (n=49)</i>

A total of 32 samples were taken by Leuchter, three of which were measured twice by Alpha Laboratories, *i.e.* there was a large enough quantity to perform two separate assays upon them (see Appendix 1 of *The Leuchter Report*). That gave altogether 35 assays performed, of which 16 gave measurable iron cyanide levels, while 19 had cyanide levels too low, if any, to give a reading. We have here included all of Leuchter's measured values, except the one consisting of sealing material taken from a hot air disinfection oven.

Rudolf had 32 analyses made, four of which were repeat analyses by a different laboratory. His 'Fresenius Institute' laboratory obtained measurable values from all of them, while the other laboratory (IUS) was unable to detect any residue in two of the four samples. In addition, Rudolf also took a sample from a collapsed Bavarian farmhouse as a null test. This sample was tested by both laboratories as well (R25).

The first judgement to be made here is whether the means and standard deviations are similar enough to justify pooling the two data sets. If all of Leuchter's too-low-to-measure samples are assigned a value of 0.5 ppm (to choose the middle between nothing and the official detection limit of one ppm), then his non-DC values would go up from 1.22 ± 1.94 to an overall mean of 1.4 ppm ± 1.8 for n=33. Thereby the Leuchter and Rudolf data sets are seen not to differ significantly, and we therefore felt at liberty to pool the two data sets.

Having done that, a *two-thousandfold differential* between the two groups is evident. The data, of cyanide wall-measurements fall into two very clearly separate groups with no overlap whatsoever. We here have no further comments to make upon the DC wall-sample values.

Homicidal Gas Chambers

There is no record of a large, homicidal cyanide gas chamber ever existing either prior to or after World War Two. There is a widespread agreement, however, that they did so exist and extensively function in Poland during the war. Indeed one can be jailed in ten European nations for publicly expressing doubt of such a thing. We are not concerned to debate the technical details of such large homicidal cyanide gas chambers (HGC). Our concern lies solely in defining the category of HGC in terms of what brickwork was sampled by Leuchter and then by Rudolf.

By a 'control' sample we mean one taken from a room that has not been recorded or alleged to have functioned as a gas chamber, neither for humans nor for clothes or bedding, *i.e.* it has been neither a DC nor an HGC. For ascertaining this group, we have here used the careful work of Desjardins, who in 2007 published a new analysis of his 1996 visit to Auschwitz-Birkenau, where he re-traced the sites sampled by Leuchter, commenting on the locations of each sample. [34] Thus three primary sources remain available for locating the sample sites: video footage taken during the Leuchter sampling, maps drawn up afterwards, and the reconstruction by Mr Desjardins. [35] Thereby we have been able to group the data for example by outdoor/exposed versus indoor/unexposed specimens, as mentioned, but also and more importantly by *homicidal gas chambers* (HGC) versus background or control levels. Major textbooks have pointed to the buildings which reportedly functioned as HGCs, [36] and clearly the main motivation of these chemical wall-sampling investigations has focused upon these.

Leuchter sampled from five locations which have generally been alluded to as 'Kremas' in the literature, which is a German abbreviation for crematoria. Taken from the walls of these locations, Leuchter's sample numbers stemming from locations said to have been HGCs were, Desjardins concluded: Krema 2: 1-7; Krema 3: 8-11; Krema 4: 20; Krema 5: 24, and Krema 1: 25-27 and 29-31, totalling 19 samples, three of which have been analysed twice, hence 22 analytical results altogether. The 'control' samples then become those taken from locations within those buildings which are not claimed to have been part of a HGC, *i.e.* Krema 4: 13-19; Krema 5: 21-23, and Krema 1: 28, totalling 11. These samples came from locations which had been a washroom, a chimney room and other unidentified rooms not associated with the use of toxic gases. Obtaining the mean values of the two groups gave:

HGCs (n=22): 1.6 ± 2.0 ppm

Controls (n=11): 1.28 ± 1.21 ppm

The statistically insignificant 21% difference between the means of these two groups fails to indicate a historical difference in terms of their exposure to cyanide gas.

Concerning wall exposure to the elements, Desjardins, after carefully retracing the steps of Leuchter on a 1996 visit to Auschwitz and watching the film that had been made of Leuchter's sampling, commented:

"Leuchter's samples, numbered 25 through 31, extracted from Crematorium I... taken from a facility which was not destroyed and has remained intact since the end of the war, were not exposed to the elements. The same might be said for samples 4, 5 and 6 taken from Crematorium II. Leuchter removed these samples from a pillar, wall and ceiling which, though accessible, were nevertheless well protected against wind, rain and sun."

Proceeding likewise by obtaining the two means, using the same data as before, gave:

Sheltered rooms (n=13): 1.77 ± 2.1 ppm

Exposed surfaces (n=20): 1.32 ± 1.6 ppm

That so slight a decrease in iron cyanide levels has taken place over four decades is indeed remarkable and accords with what is known about the insolubility and permanence of Iron Blue.

Rudolf took three samples from the HGC walls (from what is called the Krema-II morgue), obtaining in four analyses values of 7.2, 0.6, 6.7 and 0 ppm, listed as the first three samples of his data-table (Fig 19, pp. 254f.). Within what we are calling the 'control' group, he investigated plaster versus mortar absorption of cyanide. For near-surface plaster he found a mean of 1.2 ± 1.4 ppm (n=7, his Samples 4,5,7,8(twice),10,23); while for mortar he found 0.2 ± 0.1 ppm (n=3, Samples 6,21,24). Thus, the mortar in between the bricks held a relatively lower level of iron cyanide.

Table 5 lists the total Leuchter data, as before assigning values of 0.5 ppm to his samples that were too low to measure. The six Leuchter samples from Krema 1 are {3.8, 1.3, 1.4, 7.9, 1.1, 0.5}ppm, plus his seven samples from Krema II are {0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5 }ppm. Also assigning 0.5 ppm to samples below the detection limit, the four Rudolf samples from Krema II are {7.2, 0.6, 6.7, 0.5}. Rudolf took his controls from two lots of inmate barracks (Samples 5-8 (where 8 was analysed twice) and 23-24), from walls not part of an original delousing chamber (Samples 10 & 21) as well as from a collapsed Bavarian farm house (Sample 25, analysed twice), giving 11 altogether: {0.6, 0.1, 0.3, 2.7/0.5, 0.3, 0.1, 3.6, 0.3, 9.6/9.6}. Combining these gives us:

Table 5: Mean Cyanide Values of Homicidal Gas Chambers and Control Locations, ppm

Sampler	Mean HGC value	Mean 'control' value
Rudolf	3.8 ± 3.7 (n=4)	2.5 ± 3.7 (n=11)
Leuchter	1.6 ± 2.1 (n=22)	1.3 ± 1.2 (n=11)
<i>Combined</i>	1.9 ± 2.4 (n=26)	1.9 ± 2.8 (n=22)

Hence the statistical difference between the two groups of samples is virtually non-existent. Assuming for the sake of argument that the analytical results are reliable, only two options remain: either these other buildings exhibited unfavourable conditions for the formation of these compounds during the war years, or they were not at all or only rarely exposed to HCN, presumably for delousing of the respective premises. But, if anyone reckons that the remains of a wartime homicidal cyanide gas chamber can be identified, which has somehow been omitted from the several wall-samplings to-date, we would be keen to attempt some further sampling to be taken from it, expecting that it would show some elevated level of residual cyanide.

Conclusion

The walls of the delousing chambers at Auschwitz and Auschwitz-Birkenau have been found to have high or saturation levels of iron cyanides, indicating regular and intense exposure to hydrogen cyanide gas. All other buildings of that camp where samples have been taken have much lower levels of total cyanide, if any. The reason for this has yet to be agreed upon scientifically.

However, the published analytical results of total-cyanide analyses are hampered by the fact that the method used does not seem to provide reliable results for cyanide levels approaching the detection limit. Not even the value of the only sample with a high cyanide content which was re-analysed was reproduced within an acceptable margin.

Whereas the study by Markiewicz *et al.* detecting merely soluble cyanides was funded by a government research project and hence could draw on sufficient resources to conduct careful calibrations and to re-

analyse every sample twice, the studies by Leuchter and Rudolf had to rely on commercial laboratories who did not (Rudolf), or only in a few exceptions (Leuchter) re-analyse any of their samples. Rudolf actually had to hand some of his samples to another laboratory, which may also have introduced (or eliminated) systematic errors.

Considering that the methods used by Leuchter and Rudolf were not designed for solid samples and are known to be prone to inaccuracies, especially in the presence of large amounts of carbonates as was the case in some (Leuchter), if not most (Rudolf) of their samples, it is first necessary to establish a method which can detect total cyanide with reliability and accuracy in such solid, high-carbonate samples before any definite conclusion can be drawn from any analytical results.

On the other hand, the study undertaken by Markiewicz *et al.*, although more thorough and hence reliable when it comes to the results of their analysis, used an analytical procedure which excluded nearly all of the cyanide. The mystery of its claimed vastly higher accuracy (“The IFFR used a much more sensitive method [than Leuchter or Rudolf]. Their sensitivity was 3-4µg/kg, i.e., 300 times more sensitive” according to chemist Richard Green.) would need some further discussion before a proper replication which we are here advocating. The Polish study used a fairly comparable colorimetric assay procedure, and it remains opaque to us how a 1947 method could have claimed to attain such orders of magnitude higher accuracy, in parts per billion of solid-wall cyanide rather than parts per million.

We hope that a replication of the results of both types of analytical methods can be performed by reliably measuring both the permanent and soluble cyanide contents in samples taken from all locations of interest. This should be conducted in a country where the expression of doubt is not a crime. As for example Karl Popper argued, doubt is inherent in the scientific method,[\[37\]](#) and the necessary calm debate needed for resolving this emotive issue cannot be reached unless doubt is permitted. For this reason we would like to see a UK or US investigation, even though the phenomenon pertains to central Europe.

There is an honoured scientific tradition of the *experimentum crucis*, or key experiment, whereby the choice between conflicting theories is decisively resolved: what would it be in this case? Has it already been performed? Ideally we would like to see a virtual reality reconstruction of the several chambers and walls here discussed, showing where old, “genuine” brickwork is located and the various points of sampling to-date, whereby different groups could debate and agree upon where any further sampling should be conducted.

We are composing this in the year of the 300th anniversary of the great calculus controversy between Leibniz and Newton. Fierce national passions were there involved, although few could really grasp the difference between the Leibnizian differentials and the Newtonian fluxions: we are likewise not objecting to heated debate – as long as it does not spill over into *ad hominem* insult, career termination etc., which has somewhat impeded previous discussion – but this time one which would revolve around the obscure equations of the iron-cyanide bond.

Notes:

[\[1\]](#)

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- [2] 60 Barrett Road, London E17 9ET, UK
- [3] Cf. E. Emmerling, in *Holzschädlingbekämpfung durch Begasung* (Ed.: Michael Petzet), Arbeitshefte des Bayerischen Landesamtes für Denkmalpflege, vol. 75, Lipp-Verlag, Munich, 1995, pp. 43-56; D. Grosser, E. Roßmann, "Blausäuregas als bekämpfendes Holzschutzmittel für Kunstobjekte," *Holz als Roh- und Werkstoff*, 1974, 32, 108-114; Günter Zimmermann (ed.), *Bauschäden Sammlung*, vol. 4, Forum-Verlag, Stuttgart, 1981, pp. 120f.; similar: <http://www.pfarrei-untergriesbach.de/pfarrbrief11.htm>.
- [4] Alternatively the oxidation of CN^- could also merely reach the stage of cyanate OCN^- .
- [5] J.C. Bailar, *Comprehensive Inorganic Chemistry*, Vol. 3, Pergamon Press, Oxford, 1973, p. 1047.
- [6] Fred A. Leuchter, *An Engineering Report on the Alleged Execution Gas Chambers at Auschwitz, Birkenau and Majdanek, Poland*, Samisdat Publishers Ltd., Toronto, 1988; republished as: Fred A. Leuchter, Robert Faurisson, Germar Rudolf, *The Leuchter Reports. Critical Edition*, 2nd ed., Theses & Dissertations Press, Chicago, 2005.
- [7] First published in German: Rüdiger Kammerer, Armin Solms (eds.), *Das Rudolf Gutachten*, Cromwell, London, 1993; in English available as: Germar Rudolf, *The Rudolf Report*, Theses & Dissertations Press, Chicago, 2003; 2nd ed., The Barnes Review, Washington, DC, 2011.
- [8] John C. Ball, *The Ball Report*, Ball Resource Services Ltd., Delta, BC, Canada, 1993, pp. 10f.; online at <http://germarrudolf.com/wp-content/uploads/2012/05/BallReport-OCR.pdf>. Ball has a degree in geology and worked as a mineral exploration geologist.
- [9] Jan Markiewicz, Wojciech Gubala, Jerzy Labedz, "A Study of the Cyanide Compounds Content in the Walls of the Gas Chambers in the Former Auschwitz and Birkenau Concentration Camps," *Z Zagadnien Nauk Sadowych (Journal for Issues of the Forensic Sciences)*, 1994, 30, 17-27.
- [10] To find any trace of such cyanides after 50 years (more than 18,000 days), the half-life would have to be considerably higher than ca. 2 years (0.1% loss per day).
- [11] The Polish team analysed each sample three times and could reproduce most of their values within acceptable limits, although it is unclear what they actually detected when considering the just-mentioned issue of fast decay.
- [12] As note 7, p. 19. This hypothesis was later quoted by Richard J. Green, "A Study of the Cyanide Compound Content in the Walls of the Gas Chambers in the Former Auschwitz and Birkenau Concentration Camps," in *Holocaust Denial: Demographics, Testimonies and Ideologies* (Ed.: John C. Zimmerman), University Press of America, Lanham, Mass., 2000, p. 260; and then by Achim Trunk, "Die todbringenden Gase," in *Neue Studien zu*

nationalsozialistischen Massentötungen durch Giftgas (Eds.: G. Morsch, B. Perz), Metropol Verlag, Berlin, 2011, pp. 46f., all by merely referring to each other.

- [13] Josef Bailer, "Der Leuchter-Bericht aus der Sicht eines Chemikers," in *Amoklauf gegen die Wirklichkeit* (Ed.: Dokumentationszentrum des österreichischen Widerstandes, Bundesministerium für Unterricht und Kultur), Vienna, 1991, pp. 47-52; later reprinted in *Wahrheit und Auschwitzlüge* (Eds.: B. Bailer-Galanda, Wolfgang Benz, Wolfgang Neugebauer), Deuticke, Vienna, 1995, pp. 112-118. Bailer's chemical statements cite no references.
- [14] With an increasing amount of cement contained in plaster or mortar, the latter's alkalinity lasts increasingly long, for weeks in cement-less lime plaster to decades in high-cement mortars and concretes; cf. N.V. Waubke, *Transportphänomene in Betonporen*, Dissertation, Braunschweig, 1966; W. Czernin, *Zementchemie für Bauingenieure*, Bauverlag, Wiesbaden, 1977, pp. 49f.; W.H. Duda, *Cement Data-Book*, Bauverlag, Wiesbaden, 1976, pp. 4ff.
- [15] M.A. Alich, D.T. Haworth, M.F. Johnson, "Spectrophotometric studies of hexacyanoferrate(III) ion and its reaction with iron(III) in water and ethanol," *J. Inorg. Nucl. Chem.* 1967 29, 1637-1642.
- [16] H. Ferch, H. Schäfer, *Schriftenreihe Pigmente Nr. 77*, Degussa AG, Frankfurt, 1990.
- [17] J.A. Sistino, in *Pigment Handbook* (Ed.: Peter A. Lewis), Vol. 1, Wiley and Sons, New York, 1974, pp. 401-407; H. Beakes, *Paint & Coatings Industry Magazine*, 1954, 69(11), 33f.
- [18] See G. Rudolf, *The Rudolf Report*, Theses & Dissertations Press, Chicago, Ill., 2003, color plates outside of numbered pages (the 2nd ed. quoted in Note 7 has color photos only on the front cover).
- [19] See C. Mattogno, J. Graf, *Concentration Camp Stutthof*, Theses & Dissertations Press, Chicago, 2003, photos 13 & 14; J. Graf, C. Mattogno, *Concentration Camp Majdanek*, Theses & Dissertations Press, Chicago, 2003, photos XIII, XIV, XIX; M. Berenbaum, *The World Must Know*, Little, Brown & Co., Boston, 1993, p. 138.
- [20] Richard Green has suggested that the Iron Blue stains on outside walls of the delousing chambers at the Auschwitz, Birkenau, Stutthof and Majdanek camps may have been caused by items "soaked with aqueous solutions of HCN" and leaned against such walls: R.J. Green "Report of Richard J. Green, PhD," introduced in evidence during the libel case before the Queen's Bench Division, Royal Courts of Justice, Strand, London, David John Cawdell Irving v. (1) Penguin Books Limited, (2) Deborah E. Lipstadt, ref. 1996 I. No. 1113, 2001, p. 18 (www.holocaust-history.org/irving-david/rudolf/affweb.pdf). Since no "aqueous solutions of HCN" have ever been available for disinfection, let alone that they could and would have been used, since it would have been extremely dangerous to handle, this hypothesis may be dismissed here as extremely unrealistic.

- [21] In an interview by Errol Morris in his documentary *Mr. Death: The Rise and Fall of Fred A. Leuchter, Jr.*, Fourth Floor Productions, May 12, 1999; VHS: Universal Studios, 2001; DVD: Lions Gate Home Entertainment, 2003 (<http://www.video.google.com/videoplay?docid=654178281151939378>); see also: *The Pelt Report*, introduced in evidence during the libel case before the Queen's Bench Division, Royal Courts of Justice, Strand, London, David John Cawdell Irving v. (1) Penguin Books Limited, (2) Deborah E. Lipstadt, ref. 1996 I. No. 1113, p. 307 (<http://www.holocaustdenialtrial.org/en/trial/defense/van>).
- [22] B. Kulaszka (ed.), *Did Six Million Really Die? Report on the Evidence in the Canadian "False News" Trial of Ernst Zündel – 1988*, Samisdat Publishers Ltd., Toronto, 1992, p. 363 (court protocol p. 33-9291).
Online: http://archive.org/details/didSixMillionReallyDie_452
- [23] William Braker, Allen L. Mossman, *Matheson Gas Data Book*, Matheson Gas Products, East Rutherford, 1971, p. 301; R.C. Weast (ed.), *Handbook of Chemistry and Physics*, 66th ed., CRC Press, Boca Raton, Fla. 1986, p. E 40.
- [24] L. Schwarz, W. Deckert, "Experimentelle Untersuchungen bei Blausäureausgasungen," *Z. Hygiene und Infektionskrankheiten*, 1927, 107, 798-813; *ibid.*, 1929, 109, 201-212.
- [25] Compare www.wufi-wiki.com/mediawiki/index.php5/Details:WaterVaporDiffusion; Hartwig Künzle, *Simultaneous Heat and Moisture Transport in Building Components*, Fraunhofer IRb Verlag, Stuttgart, 1995, p. 24 (http://www.civil.uwaterloo.ca/beg/CE708/PhD_Kuenzel.pdf).
- [26] Color Image 3 in G. Rudolf, *op. cit.* (note 18); similar but less pronounced at Majdanek, *ibid.*, Color Image 7.
- [27] The western wall of this delousing chamber is an internal wall separating it from other parts of the building.
- [28] J. Epstein, "Estimation of Micro-Quantities of Cyanide," *J. Ind. Eng. Chem.*, 1947, 19, 272-274.
- [29] The construction damage cases reported in Note 3 indicate that it took many months if not more than a year for the conversion of adsorbed HCN to blue stains caused by Iron Blue to be complete. The final step of that reaction, binding Fe³⁺ to the soluble, hence mobile hexacyanoferrate(II), depends on the availability of Fe(III) (acidity, mobility, etc.).
- [30] See Ben D. Giudice, Brant Jorgenson, Michael Bryan, "Problems Associated with Using Current EPA Approved Total Cyanide Analytical Methods for Determining Municipal Wastewater Treatment Plant NPDES Permit Compliance," Central Valley Regional Water Quality Control Board, Tentative Order 1106, #18, Sacramento, Cal., 9/10 June 2011.
Online: www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/11

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- [31] DIN 38 405, section D13 and D14, respectively.
- [32] About the prescribed procedure see the German wartime instruction as published by the German occupational authorities in Prague in 1943 and as filed during the Nuremberg Trial in 1946, Document NI-9912; a translation can be found in J.-C. Pressac, *Auschwitz: Technique and Operation of the Gas Chambers*, Beate Klarsfeld Foundation, New York, 1989 note 22), pp. 18-20.
- [33] Diatomaceous earth as carrier material had been abandoned several years before the war; hence expert literature during the war only referred to “Erco” = gypsum with some starch in it (next to *Pappscheiben* = cardboard made of wood fibers), cf. R. Irmischer, “Nochmals: ‘Die Einsatzfähigkeit der Blausäure bei tiefen Temperaturen,’” *Zeitschrift für hygienische Zoologie und Schädlingsbekämpfung*, 1942, pp. 35-37. This was confirmed by the REM analysis of original Auschwitz Zyklon B carrier samples as supplied by the Auschwitz Museum: H.W. Mazal, “Zyklon-B: A Brief Report on the Physical Structure and Composition,” <http://www.holocaust-history.org/auschwitz/zyklonb/>
- [34] D. Desjardins, “The Leuchter Report, Revisited,” Oct 1, 2007, <http://www.codoh.comhttps://codoh.com/library/document/746>. Desjardins is a university-trained chemist.
- [35] As Rudolf’s evaluation of the Leuchter sample locations has sometimes disagreed, we cite the sample numbers given by Leuchter (both his report and that of Rudolf are online for easy access).
- [36] J.-C. Pressac, *Auschwitz: Technique and Operation of the Gas Chambers*, Beate Klarsfeld Foundation, New York, 1989; R.J. van Pelt, *The Case for Auschwitz. Evidence from the Irving Trial*, Indiana University Press, Bloomington/Indianapolis, 2002.
- [37] Karl Popper, *Objective Knowledge*, 4th ed., Clarendon Press, Oxford, 1979, pp. 347f.

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